

J1667 Test Modifications
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Air Quality Division, Vehicle Emissions Section
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Current Test

The Red Mountain opacity meters, used by Gordon-Darby Arizona Testing, Inc. (GDAT), automatically zero when commanded. One persistent problem with the J1667 has been meter return to zero after a test has been performed. To eliminate (or minimize) this problem, GDAT personnel have been instructed to clean the emitter and detector optics between tested vehicles, either immediately after, or prior to, each vehicle test.

No changes are anticipated for the J1667 procedural or methodological details. The proposed changes involve the number of snap cycles required, the test validation protocol, and the problem with post-test return to zero. This discussion will be limited to those test items for which modifications will be proposed.

A single snap-acceleration cycle begins with the engine at low idle and at operating temperature. The operator depresses the accelerator to fully open as rapidly as possible and holds it in this position for a minimum of six seconds (the engine must be operating at its maximum governed speed). At this time, the operator completely releases the accelerator to allow the engine to return to low idle. The cycle ends when the engine has idled for a minimum of six seconds. The cycle data output consists of the average opacity within a 0.5-second window centered about the maximum opacity reading. The Red Mountain hand-held terminal automatically displays the measured peak opacity value of each snap cycle. Although the Red Mountain operator instructions are unclear regarding a capability to store the value obtained from an individual snap cycle, we have been assured by GDAT that their software is capable of reading and storing all values read or displayed by the hand-held terminal.

The J1667 standard test consists of six snap cycles (three "preliminary" and three "official" cycles). The minimum time required to run six snap cycles is about 2.8 minutes. The average reported test time for the 2002 test fleet is 5.3 minutes and the maximum reported test time for the fleet is 16.65 minutes (999 seconds is probably the maximum recordable time). The reported 2002 fleet failure rate, 3.5%, suggests that the vast majority of the tested vehicles are low emitters. In fact, the 2002 J1667 test results show that the reported opacity for 93% of the fleet tested was, on an absolute basis, 10% or more below the standards.

Discussion of Modifications

First, ADEQ recommends that, if all J1667 test validity criteria are met (post-test smoke meter zero at or within 2% and arithmetic difference between the highest and lowest snap cycle corrected opacities at or within 5%), vehicles be permitted to pass after the first three "preliminary" snap cycles.

ADEQ recommends that, if the average of the first three "preliminary" snap cycles is at least 10% (absolute) below the standard, and none of the three cycles exceed the standard, the vehicle would pass unless there is reason to believe the test was not properly performed. Justification for this test modification is that, if a vehicle meets these criteria, it is highly improbable that the vehicle is capable of producing three consecutive snap cycles which constitute a failure; even if J1667 test validity criteria are met.

ADEQ also recommends that all vehicles that do not pass during the first three snap cycles (according to the criteria defined in the two preceding paragraphs) be considered as possible failures and given a minimum of an additional three snap cycles. If the second set of three snap cycles meets all "pass" requirements of J1667 or those proposed for the "preliminary" snap cycles, the vehicle would pass. Alternatively, if the second set of three snap cycles produces an average opacity which is 10% (absolute) or more above the standard for that vehicle, and none of the three cycles meet the standard, we recommend that the vehicle be failed unless there is reason to believe that the test was not properly performed. Justification for this test modification is that, if a vehicle meets these criteria, it is highly improbable that the vehicle (regardless of further conditioning) is capable of producing three consecutive snap cycles which constitute a pass, even if J1667 test validity criteria are met.

Ordinarily, an I/M fleet would be considered as three fleet segments; low emitters, high emitters, and those vehicles emitting relatively close to the standards. For the purposes of this discussion, the J1667 fleet will be considered in a similar manner. "Low emitters" are defined as those vehicles emitting at least 10% (absolute) below the applicable standard, "high emitters" are those vehicles emitting at least 10% (absolute) above the applicable standard, and the remainder of the fleet (emitting within 10% of the standards) are "borderline emitters".

We recommend that all "borderline emitters" (5.0% of the 2002 J1667 fleet) that have not passed or failed either the first or second set of snap cycles receive a third set of three snap cycles. Testing should continue beyond this point only if one of the three tests disagrees with the other two, relative to pass/fail indication, or there is reason to believe that a test was not properly performed. It should be emphasized, however, that all efforts should be made to comply with all J1667 test validity criteria.

J1667 allows a maximum of 45 seconds between the beginning of the idle following maximum governed speed and the beginning of the next snap cycle. This time period should be sufficient to allow the sampling head to be removed from the tailpipe, meter zero to be observed, the meter to be zeroed if it exceeds the 2.0% limit, and the sampling head to be replaced into the tailpipe before the next snap cycle. Regardless of whether the 45-second time limit can be met, we recommend that zero be checked (and reset if necessary) between each set of three snap cycles.

Experimental Justification

Using the waiver lane Red Mountain opacity meter and a diesel truck supplied by ADOT, various experiments were performed to establish the magnitude of meter-related test validation problems.

Summarized experimental results include:

1. Increasing the temperature of the instrument detector head above ambient (exposure to exhaust) produces meter zero instability (fluctuation in the approximate range, 2%-8%),
2. With the meter zeroed at ambient (about 70°F), three snap cycles may produce sufficient heating to cause post test zero failure,
3. Positive zero drift with heating is indicated by raw data stream change (head at about 70°F ambient – raw data = 237, head exposed to 2500rpm exhaust for about 10 minutes – raw data = 195),
4. Head temperature which is constant from zero set through opacity reading has little effect if the meter is zeroed immediately prior to reading a filter (cold head reading after zero = 47.3, hot head reading after zero = 47.0).

Summary of Recommended Test Procedure

Test Definitions

1. Snap test – three snap cycles.
2. Vehicle test – one, two, or three snap tests.

Test Fleet Opacity Definitions

1. Low emitter – The average opacity for a test is 10% (absolute) or more below the applicable standard and no single snap cycle opacity reading is above the standard.
2. High emitter – The average opacity for a test is 10% (absolute) or more above the applicable standard and no single snap cycle opacity reading is below the standard.
3. Borderline emitter – The average opacity for a test is within 10% (absolute) of the applicable standard.

Pass/Fail Criteria

1. After one snap test: Pass low emitters (only) if the criteria described in the Discussion of Modifications section are met. Continue testing high and borderline emitters.
2. After two snap tests: Pass low emitters and fail high emitters if the criteria described in the Discussion of Modifications section are met. Pass or fail borderline emitters if all J1667 pass or fail and test validity criteria are met. Continue testing all other borderline emitters.
3. After three snap tests: Pass or fail borderline emitters if all J1667 pass or fail and test validity criteria are met. Pass or fail borderline emitters if the opacity averages for all three tests are, respectively, less than or more than the applicable standard. Pass borderline emitters if the average opacity of the third snap test is below the applicable standard and the opacity of no snap in that test is above the standard. Fail borderline emitters if the average opacity of the third snap test is above the applicable standard and the opacity of no snap in that test is below the standard.
4. Continue only if the requirements described above are not met or there is reason to believe a test was not properly performed.

Procedure

1. Clean the opacity meter optics.
2. Zero the opacity meter immediately prior to testing.

3. If more than one snap test is required, remove the sensing head from the stack after each test, check zero (and adjust if necessary), replace the head into the stack, and resume testing.